Steroidal Sapogenins. LXI. Steroidal Sapogenin Content of Seeds

The results of a detailed study (7) of the steroidal sapogenins of the Joshua tree (*Yucca brevifolia*) indicated that the seeds of this species contained an unusually large quantity of saponin (analyzed as sapogenin). Because of the industrial possibilities of any seed crop, we wanted to ascertain whether other related species and genera also contained high sapogenin content in their seeds. A number of botanists, particularly H. S. Gentry, L. N. Gooding, B. H. Warnock, A. M. Woodbury and Miss Bess Peacock, collected seeds of several species of *Yucca,* two *Agave,* and one *Nolina* for analysis. The results are shown in Table I.

Sapogenins occur in plants only in the form of glycosides called steroidal saponins. The analytical procedure involves an acidic hydrolysis of the saponins to yield the steroidal sapogenins that can then be weighed and identified (1). The actual saponin content of seeds is, therefore larger, often twice that of the values shown in Table I. Since sapogenin is the useful form, the values given may be used in any assessment of the economic value of the seeds.

In general, the results for the various *Yucca* species justify the conclusion that saponins are concentrated in the seeds of the genus. Previously the leaf had been

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TABLE I

STEROIDAL SAPOGENIN CONTENT OF SEEDS

Species	Location	Sapogenin	% MFB	Sapogenins found in the leaf
Agave lecheguilla	Big Bend, Texas	hecogenin + manogenin	1.5	Smilagenin
Agave schottii	Southern Arizona	hecogenin	1.7	smilagenin gitogenin
Nolina texana	Southern Arizona	unidentified	1.8	none
Yucca arizonica	Southern Arizona	sarsasapogenin	12.0	sarsasapogenin
Yucca baccata	Superior, Arizona	sarsasapogenin	6.8	sarsasapogenin
Yucca brevifolia	St. George, Utah	tigogenin	8.0	hecogenin, tigogenin
Yucca elata	Oracle, Arizona	Sarsasapogenin	0.9	sarsasapogenin
Yucca intermedia	Las Cruces, N. Mex.		0.0	none
Yucca mohavensis	San Diego, Calif.	sarsasapogenin	6.6	----------*
Yucca peninsularis	Baja, Calif.	tigogenin	1.7	tigogenin
Yucca schottii	Fort Huachuca, Ariz.	sarsasapogenin	4.9	sarsasapogenin
Yucca whipplei	Murrieta, Calif.	tigogenin	1.9	tigogenin
Yucca sp.	Southern Arizona	sarsasapogenin	4.5	sarsasapogenin
Yucca sp.	Sonora, Mex.	sarsasapogenin	6.2	sarsasapogenin
Yucca sp.	Chihuahua, Mex.	sarsasapogenin	7.9	----------*

*Not determined.

considered to contain the highest amount of sapogenin, at least in *Yucca* and *Agave* species. Studies of the sapogenin content of the leaves of many *Yucca* and *Agave* indicate that 1 to 2% sapogenin on a dry basis was the maximal quantity obtainable (3, 4, 5). Of the 12 samples of *Yucca* seed tested, eight contained at least 4.5% sapogenin; of these, five ranged from 6.6-12.0%. The predominant sapogenin found was sarsasapogenin. Occasionally, tigogenin was present. In almost all cases the same sapogenins were found in the seeds and leaves.

Too few examples of *Agave* and *Nolina* seed were obtained to permit generalizations. The concentration of the sapogenin in the seed was not unusually high for the seeds we tested. Moreover, the sapogenins in the seed and corresponding leaf were different.

Previously, we have shown that sarsasapogenin could be converted to cortisone (2). The large amount of sarsasapogenin in the seeds and the absence of interfering substances make the extraction and isolation of this sapogenin a simple process similar to that described for tigogenin from Joshua tree seeds (7). *Yucca* species are hardy and will grow in almost any location in the United States (6), but much agronomic and genetic research will be required before *Yucca* can be recommended as a cultivated crop. Since seeds are often high in protein and/or oil, *Yucca* seed should be investigated for these possibilities.

Literature Cited

1. Kenny, H. E., Fenske, C. S., and Wall, M. E. Analytical procedures for steroidal sapogenins. Paper in preparation.
2. Kenney, H. E., Weaver, E. A., and Wall, M. E. Steroidal Sapogenins. XLVII. Preparation of 16α, 17α-epoxy-11α-hydroxy-pregnane-3, 20-dione from 5β-spirostanes. Jour. Am. Chem. Soc. **80:** 5568-70. 1958.
3. Wall, M. E., Krider, M. M., Krewson, C. F., Eddy, C. R., Willaman, J. J., Correll, D. S., and Gentry, H. S. Steroidal Sapogenins. VII. Survey of plants for steroidal sapogenins and other constituents. Jour. Am. Pharm. Assoc. (Sci. Ed.) **43:** 1-7. 1954.
4. ———, Eddy, C. R., Willaman, J. J., Correll, D. S., Schubert, B. G., and Gentry, H. S. Steroidal Sapogenins. XII. Survey of plants for steroidal sapogenins and other constituents. Jour. Am. Pharm. Assoc. (Sci. Ed.) **43:** 503-5. 1954.
5. ———, Fenske, C. S., Willaman, J. J., Correll, D. S., Schubert, B. G., and Gentry, H. S. Steroidal Sapogenins. XXV. Survey of plants for steroidal sapogenins and other constituents. Jour. Am. Pharm. Assoc. (Sci. Ed.) **44:** 438-40. 1955.
6. Webber, J. M. *Yuccas* of the southwest. Agriculture Monograph No. 17, 1-97. U. S. Department of Agriculture. 1933.
7. Woodbury, A. M., Wall, M. E., and Willaman, J. J. Steroidal Sapogenins. LVII. Steroidal sapogenins from the joshua tree. Econ. Bot. **15:** 79-83. 1960.